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- USSR -

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# SOME TRACE ELEMENTS IN CANCER PATIENTS

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[Following is a translation of an article by I. S. Gul'ko in the Russian-language periodical Zdravookhraneniye Belorussii (Public Health in Belorussia), Minsk, Vol. VI, No. 4, April 1960, pages 20-23.]

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One of the most important ways to discern the causes of the origin and development of cancer and for working out methods for its diagnosis and treatment is the quantitative and qualitative study of the chemical composition and metabolism both of the cancer itself and the entire body of the patient.

Despite the use of all modern research methods, the study of the chemical and physiological properties of proteins and nucleic acids in a tumor has not revealed any differences in their structure as compared with the proteins and nucleic acids in normal tissues. In recent years the use of tagged compounds has established the identity of the mechanisms of the formation and decomposition of proteins and nucleic acids in both tumor and normal tissues. No substantial differences have been found in studying the different enzymatic transformations of the amino acids -- deamination, transamination and the formation of hormones, vitamins, pigments, etc., from the amino acids. Differences exist only in the intensity of these processes which is determined by the different activities of the enzyme systems.

As a result of a change in the enzymatic activity of tumors there take place changes in the corresponding protein fractions, nucleic acids and other ingredients.

Among the substances which effect the enzymatic processes, the trace elements deserve particular attention. They have a favorable effect on the body when their assimilation corresponds to physiological requirements. When large doses of trace elements are assimilated they may have a pathological effect. In works by P. Horn, Burne and others, L. Teleky, C. H. Grogan and others we have indications of the high incidence of cancer, particularly of the respiratory tract, in workers subject to prolonged exposure to chromium, nickel, cobalt and their compounds. A number of experimental works have also been published by Schinz and others, Hueper, M. B. Hoaglend, J. A. Thomas and

others, J. C. Heath, S. Hatem, which show that in laboratory animals arsenic, berillium, chromium, cobalt, nickel and certain of their compounds may induce the formation of a malignant tumor.

But not all the trace elements have the same effect. For instance, attempts to cause a malignant tumor with manganese or cadmium were unsuccessful (J. C. Paterson). J. Balo and others have indicated that manganese malate inhibits the growth of certain experimental tumors, exhibiting a tendency to alter metabolism in the tumor from anaerobic to aerobic.

The aim of this study was to detect the amount of certain trace elements in tumors, blood and organs of cancer patients as compared to the normal state.

For a control we used data which we had obtained from examining the blood of 16 first-time donors and the organs of 10 healthy persons who had died a sudden violent death.

116 cancer patients were examined. The distribution of the patients by tumor location, age and sex is represented in Table 1.

TABLE 1

| Location of cancer | No. of patients examined | Men | Women | Age to 29 | 30-39 | 40-49 |
|---|---|---|---|---|---|---|
| Cancer | 60 | 33 | 27 | 1 | 6 | 18 |
| Lungs | 16 | 11 | 5 | 1 | 3 | 1 |
| Breast | 18 | 1 | 17 | 1 | 7 | 4 |
| Rectum | 13 | 7 | 6 | 1 | 2 | 3 |
| Other organs | 9 | 5 | 4 | - | 2 | 2 |
| Total | 116 | 57 | 59 | 4 | 20 | 28 |

TABLE 1 (continued)

| Location of cancer | Age 50-59 | 60-69 | 70-79 |
|---|---|---|---|
| Cancer | 24 | 10 | 1 |
| Lungs | 5 | 5 | 1 |
| Breast | 5 | 1 | - |
| Rectum | 4 | 3 | - |
| Other organs | 2 | 3 | - |
| Total | 40 | 22 | 2 |

TABLE 2

TRACE ELEMENT CONTENT OF THE BLOOD IN HEALTHY AND CANCER PATIENTS
(MICROGRAMS PER 100 MILLILITERS)

| | | Spectrographic | | | | Colorimetric | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | No. examined | Zinc in whole blood | Copper in whole blood | Manganese in whole blood | No. examined | Zinc in serum | No. examined | Cobalt in whole blood | No. examined | Nickel in whole blood |
| In normal health | Average | 16 | 465-1090 | 69-144 | 7.8-20 | 16 | 100-175 | 16 | 5-7.6 | 16 | 6.8-18 |
| | fluctuation | | 820±148 | 108.6±12.5 | 12±3.6 | | 134±20.4 | | 6.2±0.55 | | 11.1±2.8 |
| In cancer: | | | | | | | | | | | |
| At admittance | Average | 96 | 336-1300 | 56.8-230 | 5.2-34 | 91 | 48.2-220 | 63 | 4.3-13.4 | 47 | 7.2-22 |
| | fluctuation | | 732.2±284 | 136±40 | 14.0±5.45 | | 98.9±34.8 | | 7.5±2.23 | | 14.0±3.7 |
| At discharge after surgery | Average | 45 | 358-1200 | 56-273 | 6.76-25.7 | 41 | 46-140 | 28 | 4.72-9.8 | 21 | 8.18.33[sic] |
| | fluctuation | | 632±197 | 143.5±43.2 | 14.23±4.46 | | 80.0±20.8 | | 7.47±1.38 | | 14.45±2.94 |

TABLE 3
TRACE ELEMENT CONTENT OF CANCERS OF THE ORGANS
(IN MICROGRAMS PER 100 GRAMS OF FRESH TISSUE)

| | | No. examined | Zinc | Copper | Manganese | Cadmium | No. examined | Cobalt | No. examined | Nickel |
|---|---|---|---|---|---|---|---|---|---|---|
| Lungs (normal) | Aver. | 10 | 1280-3920 | 87-270 | 11.0-30.8 | Trace-22 | 10 | 4.5-8.7 | 10 | 8.2-30 |
| | fluc. | | 2105± 680 | 153±49.6 | 22[?]6.1 | 18±5.2 | | 6.2±1.16 | | 15.1±5.45 |
| Lung cancer Primary | Aver. | 10 | 1200-2110 | 162-408 | 11.2-28 | 10-30 | 7 | 4.5-15 | 5 | 8.3-32 |
| | fluc. | | 1671± 331 | 296.5±77.4 | 19.66±5.9 | 18.99±5.5 | | 8.9 | | 21.2 |
| Metastatic | Aver. | 3 | 1490-3000 | 173-330 | 10.7-29 | 15.0-23.0 | 2 | 8.2-12 | 1 | 16 |
| | fluc. | | 2203 | 247.3 | 22.2 | 19.3 | | 10.1 | | |
| Stomach (normal) | Aver. | 10 | 2240-5000 | 138-325 | 10.7-42 | Trace-16 | 10 | 3.5-8.0 | 10 | 12-24.2 |
| | fluc. | | 3310± 332 | 236±55.6 | 24.7±8.3 | 8±4.8 | | 5.2±1.26 | | 18.1±3.28 |
| Stomach cancer | Aver. | 25 | 1758-4300 | 145-590 | 14.8-41 | Trace-21.7 | 15 | 5-16 | 13 | 16-32.6 |
| | fluc. | | 3044.7±615 | 277.36±71.5 | 28.6±6.95 | 9.49±4.2 | | 8.84±2.8 | | 22±4.9 |
| Rectum (of patients) | Aver. | 4 | 1780-2200 | 100-423 | 30-72 | Trace-19 | 2 | 4.4-5.0 | 4 | 33-60 |
| | fluc. | | 2020 | 248 | 40.95 | 5 | | 4.7 | | 44.0 |
| Rectal cancer | Aver. | 4 | 2680-3000 | 350-430 | 26.0-40.0 | Trace-20 | 2 | 7.0 | 4 | 35.0-72 |
| | fluc. | | 2562 | 377.5 | 32.8 | 7.6 | | | | 46.2 |
| Breast cancer | Aver. | 12 | 1930-3392 | 200.2-420 | 18.2-40 | Trace-22 | 3 | 8.9-15.0 | 2 | 19-41 |
| | fluc. | | 2666± 439 | 281±61 | 30±6.4 | 10.58±5.2 | | 12.5 | | 30 |
| Liver (normal) | Aver. | 10 | 6560-11150 | 495-1070 | 82-136 | 14.6-69.5 | 10 | 8.1-24 | 10 | 7-19 |
| | fluc. | | 8000±1380 | 656±140.5 | 101±17.2 | 52.1±13 | | 16±4.4 | | 10.8±3.12 |
| Metastasis to liver | Aver. | 7 | 2000-3700 | 116-478 | 23.8-32.2 | 16-42 | 4 | 7.2-15 | 3 | 22-53 |
| | fluc. | | 2853 | 266 | 28.97 | 27.74 | | 11 | | 34.3 |
| Metastasis to lymph nodes | Aver. | 4 | 1415-3000 | 138-291 | 22.4-37.4 | 17-23 | - | - | 1 | 12 |
| | fluc. | | 2334 | 221.7 | 28.3 | 19.5 | - | - | | |

Zinc, copper, manganese and cadmium were determined by emission spectral analysis; nickel, cobalt and zinc in serum and organs were determined by the colorimetric method. Zinc in the organs was determined by both methods.

A statistical interpretation of the data obtained as presented in Table 2 revealed a substantial increase in the whole blood of cancer patients of the amount of copper, cobalt, nickel and a substantial reduction in the amount of zinc in the blood serum (in all these cases the observable difference was 3 times greater than the average error). It revealed a correlation between the amount of copper, manganese and cobalt in the whole blood of cancer patients and the degree of anemia: as the anemia increases the amount of these trace elements in the blood increases.

The amount of these elements in the tumor tissue (primary and metastatic) and in healthy organs is presented in Table 3.

As we see from the table all primary tumors contain more copper, cobalt and nickel than the corresponding healthy tissues. It was also discovered that a primary cancer and its metastases to the liver, lungs and lymph nodes have an almost identical concentration of the trace elements being studied.

An analysis of the data obtained showed that the trace element content varies not only in a tumor but in the blood and organs of cancer patients. These data confirm the tenet that cancer is not a local process but a disease of the entire organism.

We assume that the change in the trace element content of tissues and organs depends on the amount of substances in them which are capable of binding and inhibiting these trace elements. The identical amount of trace elements in primary cancers and their metastases confirms the common nature of their morphology and metabolism.

In conclusion let us point out that in all cancer patients, regardless of the primary location of the cancer, we found almost identical changes in the amount of these trace elements in the blood and organs.

## CONCLUSIONS

1. Cancer as a disease is regularly accompanied by a quantitative disturbance in the normal amount of trace elements (Zn, Cu, Mn and Co) in the body of patients, regardless of the location of the primary affection.

2. In the whole blood of cancer patients:

a) the Zn, Cu, Mn, Cd, Co and Ni content does not depend substantially on sex, age or clinical stage of the disease;

b) the average Zn content dropped, Cu, Co and Ni increased substantially and Mn has a tendency toward an increase;

c) with a decrease in the hemoglobin content of the blood there is an increase in the Cu, Mn and Co content.